EARTHWORKS

Sources of Oil and Gas Air Pollution

A variety of **air contaminants** are emitted throughout the oil and gas development process, and these compounds are released from a number of sources:

- Blowouts
- Condensate tanks
- Construction activity
- Dehydrators
- Engines
- Flaring
- Fugitive emissions
- Pits
- Vehicles
- Venting

Condensate tanks: Some natural gas wells produce a semi-liquid condensate along with the gas. Condensates are hydrocarbons that are in a gaseous state within the reservoir (prior to production), but become liquid during the production process. Condensates are composed of hydrocarbons (typically those containing five or more carbon molecules), as well as aromatic hydrocarbons such as benzene, toluene, xylenes and ethylbenzene (BTEX).

Condensates may give off a characteristic hydrocarbon or petroleum-type smell. BTEX give off a sweet, aromatic odor. Most people can smell benzene when it reaches levels of approximately 1.5 - 5 parts of benzene per million parts of air (ppm). The Occupational Safety and Health Administration (OSHA) has set

maximum exposure levels for workers at 1 ppm (over an 8-hour period) and 5 ppm (over a 15-minute period). At levels above 150 ppm some people may begin to experience serious and irreversible health effects.

The vapors of benzene, toluene and xylenes are heavier than air and may accumulate in low-lying areas.

Construction activity: a certain amount of construction accompanies every phase of oil and gas development (exploration, field organization, production, and site abandonment). Each requires disturbing the soil to some degree through the use of construction machinery. These activities generate particulate matter and stir up dust, which in turn react with the other prerequisites to form ground-level ozone, or smog.

Dehydrators:
If the gas wells use glycol dehydrators to remove water from the gas, the dehydrator may release aromatic organic chemicals to the atmosphere. If the natural gas undergoing dehydration contains benzene, toluene, or other volatile organic compounds, significant quantities of these compounds can be released when the glycol solution undergoes regeneration.

Engines
Drilling, completion and workover trucks, rigs and equipment such as pumps typically run off of diesel-powered or gasoline engines. The exhaust fumes from gasoline and diesel fuels can produce emissions that are noticeable to people living downwind.

Polycyclic aromatic hydrocarbons (PAHs) are found in exhaust from motor vehicles and other gasoline and diesel engines. A long list of other air pollutants, including nitrogen oxides, carbon monoxide, BTEX, formaldehyde and metals are also contained in diesel fuel combustion products.

Flaring
Flaring is the practice of burning gas that is deemed uneconomical to collect and sell. Flaring is also used to burn gases that would otherwise present a safety problem. It is common to flare natural gas that contains hydrogen sulfide (i.e., sour gas), in order to convert the highly toxic hydrogen sulfide gas into less toxic compounds.

Sour gas flare in Alabama

Flares emit a host of air pollutants, depending on the chemical composition of the gas being burned and the efficiency and temperature of the flare. Flaring results in hydrogen sulfide emissions if hydrogen sulfide is present in large enough amounts in the natural gas. There may also be additional by-products formed if some of the chemicals used during the drilling or hydraulic fracturing process are converted to a gaseous form and are burned along with the natural gas.

The Ventura County Air Pollution Control District, in California has estimated that the following air pollutants may be released from natural gas flares: benzene, formaldehyde, polycyclic aromatic hydrocarbons (PAHs, including naphthalene), acetaldehyde, acrolein, propylene, toluene, xylenes, ethyl benzene and hexane. Researchers in Canada have measured more than 60 air pollutants downwind of natural gas flares.[1]

Fugitive Emissions
Fugitive emissions are unintentional leaks of gases. This may occur from breaks or small cracks in seals, tubing, valves or pipelines, as well when lids or caps on equipment or tanks have not been properly closed or tightened. When natural gas escapes via fugitive emissions, methane as well as volatile organic compounds (VOCs) and any other contaminants in the gas (e.g., hydrogen sulfide) are

released to the atmosphere.

Recently, while on a tour of oil and gas fields in Weld and Adams counties, a team of high-tech Environmental Protection Agency investigators used an infrared camera to look for fugitive emissions, which are normally invisible to the naked eye. They aimed their camera at pipelines, valves and hatches atop storage tanks, the EPA regulators found numerous sources of fugitive emissions. According to a story in the Rocky Mountain News, *"in one case, an open hatch atop a storage tank was gushing such a tremendous volume of emissions into the air that one participant jokingly compared it to the eruption of Mount Vesuvius near the ancient city of Pompeii."*

This video (H/T Bluedaze) reveals fugitive emissions from several Barnett Shale gas well sites.

Dr. Theo Colburn of The Endocrine Disruption Exchange, has explained that "the tanks you see in this picture can be found across the gas fields in the US.

They look harmless as you drive by just like the other stationary equipment you see on well pads. Without an infrared camera, as in this case, that picks up the plume of the highly active volatile chemicals escaping from the tanks, no one would suspect that the tanks could possibly pose a public health problem.

As natural gas extraction continues to increase, federal, state, and local public health authorities and regulatory agencies are unprepared to deal with the problem."

Pits

Earthen pits are often used to store or evaporate produced water and waste water from natural gas dehydration or oil/gas separation units. Additionally, prior to disposal drilling wastes (muds and cements) and hydraulic fracturing (fracking) wastes are often stored in earthen or metal pits that are open to the air. There are hundreds of different chemicals that may be used during drilling, fracking and workover procedures, including acids, biocides, surfactants, solvents, lubricants and others.

Chemical compounds that are naturally present in natural gas, or chemicals that have been injected downhole during drilling, hydraulic fracturing or well workover operations, will be present in the water or wastes that are held in pits. Some of the lighter or more volatile chemicals and compounds, such as benzene, toluene,

hydrogen sulfide, etc., will escape from the produced water pits into the atmosphere. These chemicals may then be transported through the air, into nearby neighborhoods. The odors associated with the natural gases or chemicals will vary, depending on the concentrations, volumes, and combinations of chemicals released.

Vehicles

Dust from oil and gas industry vehicles

The biggest pollutant from motor vehicle traffic at oil and gas operations is dust.

Burning fuel to power trucks also emits NOx, carbon monoxide, and sulfur dioxide, as well as particulate matter. These compounds combine with VOCs to form ground-level ozone (smog).

Venting

Venting is the release of gas to the atmosphere. Venting occurs at a number of points in the oil and gas development process (well completion; well maintenance; pipeline maintenance; tank maintenance; etc.).

During oil and gas development, huge quantities of gas may vented to the atmosphere. For example, during well completion, after a well is drilled and stimulated (e.g., hydraulically fractured), the wellbore and surrounding formation must be cleaned out. The solids and fluids from the well go into pits, while the gases are allowed to escape into the atmosphere, or they are burned off (flared). It has been estimated that a single well Wyoming's Jonah field will emit 115 tons of VOCs, and 4 tons of hazardous air pollutants such as benzene, toluene, ethylbenzene, xylene and hexanes. If the gas is flared, rather than vented, the emissions of VOCs and HAPs are reduced to 29 and 1 ton, respectively; but flaring of completion gases also results in the release more than a ton of nitrogen oxides, and almost half a ton of carbon monoxide per well.[2]

The primary component of natural gas is methane, which is odorless when it comes directly out of the gas well. At gas processing facilities, chemical odorants such as mercaptans are added to methane, so that consumers are able to smell it in the event of a gas leak. In addition to methane, natural gas typically contains other hydrocarbons such as ethane, propane, butane, and pentanes. Raw natural gas may also contain water vapor, hydrogen sulfide (H2S), carbon dioxide, helium, nitrogen, and other compounds.

Almost all references to the odor of raw or wellhead natural gas state that it, like methane, is odorless. The Ohio Department of Natural Resources, however, advises landowners that one way to detect an abandoned oil or gas well on their property is if they smell "natural gas" odors coming from their tap water. So, in some cases, there may be a slight hydrocarbon odor associated with venting of natural gas.

If the concentration of H2S in the gas is high enough, there may also be a "rotten egg" odor associated with the gas.

For more information:

ENDNOTES

[1] Leahey, Douglas M., Preston, Katherine and Strosher, Mel. 2001. "Theoretical and Observational Assessments of Flare Efficiencies, Journal of the Air & Waste Management Association. Volume 51. p.1614.

[2] Russell, J. and Pollack, A. (ENVIRON International). 2005. Final Project Report: Oil And Gas Emission Inventories For The Western States. Report prepared for the Western Governors Association. Appendix A, Wyoming Emission Factor Documentation. p. A-2.

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